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### **Paper No. 23: Productivity Issues in Naval Shipbuilding**

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**VOLUME I**



**INSTITUTE FOR RESEARCH AND ENGINEERING FOR AUTOMATION AND PRODUCTIVITY IN SHIPBUILDING**

**I R E A P S**

## **PRODUCTIVITY ISSUES IN NAVAL SHIPBUILDING**

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## ABSTRACT

Productivity is looked upon by most as the key to our American standard of life; however, as evident by the successes overseas, the United States seems to be only now coming to grips with the true essence of productivity -- human resource management. This paper will look at the changing nature of productivity as it relates to job design, participative management, and the increasing use of incentives, feedback, and goal setting. Likewise, a brief discussion of organizational design and recent developments toward work motivation will point up that the real key for productivity improvements lies with management. This then will help establish why there are real productivity issues that need to be addressed in the Navy shipbuilding program in the areas of engineering design, waterfront management, and Navy Project management. The essence of these issues relate hinderances to achieving productivity improvements due to: (1) poor organizational structures which preclude inclusion of productivity considerations early in the design phase; (2) improper attention and training provided to the first level supervisors at the waterfront and the failure to recognize the valuable contribution these people could provide; and, **(3)** the crucial requirement for having qualified and experienced ship production personnel on Navy management teams.

## I. INTRODUCTION

Has the necessity to meet tight schedules and constrained fiscal demands precluded the Navy and shipbuilder from realizing their role in improving productivity? On the contrary, we feel that just because of these demands, attention to shipbuilding productivity is even more crucial. Productivity issues in Navy shipbuilding can encompass many aspects, from management to industrial capabilities. We believe however that management, in broad terms, is the key factor, both in the production environment and design development as well.

The generic definition of production is the act of producing, but we all know that in Navy shipbuilding the real definition is based upon the successful completion of a system within cost and schedule, while realizing maximum efficiency. Navy shipbuilding, by its nature, is a complex and cumbersome effort, never totally suited to optimum productivity from technology alone. Therefore, the Navy shipbuilding community must look beyond the obvious plant capability issues and look at philosophies and methodologies in the way the community conducts business and manages its projects.

This paper intends to point out the need for the entire Navy shipbuilding community, including Navy management, to examine current philosophies, to get beyond the reactive response mode and begin to reassess management capability at every technical level. There is a need to reassert ourselves to recognize the uniqueness of Naval construction **as a** specialized industry to be managed by highly experienced and dedicated shipbuilding people, who will call upon their technical experience and the recent developments in human resource management to create a positive impact on shipbuilding productivity.

Our intent here is not to attempt to provide the ultimate specification **for** management success, but with a great deal of objectivity, to make observations based on our experiences which directly and indirectly are affecting productivity today.

### The Nature of Productivity

**In** the business and commerce world, management, labor and government all recognize that productivity has been the key to our American standard of living and that steps must be taken to enhance it. Despite this fact it is interesting to note that there is no universally accepted definition of just what productivity is. That is, there is no single set of measures or indicators which a business or government agency can utilize to measure its productivity. Different measures are used in different situations. However, it is generally accepted that productivity is thought of as a ratio concept -- the ratio of the output of goods and services produced and generated by an organization divided by the input used to produce them. **In** such a labor intensive environment as the shipbuilding industry, a large share of the consumed resources is manpower -- both managerial and waterfront craftsmen. Despite major technological advances over the past fifty years, it is becoming increasingly more difficult to generate large productivity improvements purely through technology. Combined with the fact

that the current economic and fiscal situation is precluding large capital improvements in equipment and facilities, most shipyards must look to better human resources management as their best hope for improving productivity.

A major input to the productivity ratio is the whole area of utilization of human resources. Historically, efforts to improve human resource productivity have focused on asking for "more". Employees have been pressured to work harder and increase their output. In recent years, however, the potential for gains from this strategy has been blunted by legislation, unions and social norms which no longer permit the "sweatshop" mentality in our business and commercial institutions. As a result, most efforts to increase human resource productivity have come to focus more on the inputs: cutting back staffing levels as much as possible; replacing people by less expensive equipment; and so forth. People are seen as a direct expense, and productivity can be achieved by cutting this expense as much as possible.

This management attitude inevitably leads to worker resentment and work slowdown. Likewise, workers tend to view changes toward productivity improvement from managers who feel their work force is only another "direct expense" as tricks or ways to ease them out of a job.

However, many enlightened organizations are beginning to recognize a relatively new area for increasing productivity of the human resource without reducing the inputs. They are discovering that by designing new systems and managing the job with a more enlightened human resource management approach, that the workers' output increases without the necessity of working harder. In other words, these forward-thinking organizations are rediscovering the truth of the old adage, "Work smarter, not harder." This concept also applies to management and project organizations as much as it does to a waterfront welding team. As will be explained later in this paper, more enlightened use of managerial expertise in the earlier stages of the shipbuilding project can go far in alleviating construction problems for the crafts on the ship and, thus, aid in improving productivity. In a recent presentation to the Panel on Navy Shipbuilding at the University of Virginia, Mr. William E. Haggett, president of Bath Iron Works, emphasized this by asserting that "the key to achieving shipbuilding performance improvements begins with Management."

<sup>1</sup> John R. Hinrichs, *Practical Management for Productivity*. (New York: Van Nostrand Reinhold Co, 1978), p. x-xi.

<sup>2</sup> William E. Haggett, "Executing the Navy's Surface Combatant Shipbuilding Program," Sixth Annual Seminar of the Center for Oceans Law and Policy, University of Virginia, January 16, 1982.



A survey of recent developments in productivity and the changes occurring in the working place indicate that productivity changes are begun at the management and supervisory level. The Work in American Institute listed this new focus as:

Concepts of new job design which uses team work and project organizations to capitalize and maximize the strong points of the individual and builds upon the synergy of the group.

Increased effective use of incentives and feedback to increase productivity where more goal-setting processes are being applied at all levels.

Improved human resource productivity as characterized by a participative management approach that recognizes most employees as responsible mature adults who react positively to the opportunity to have some degree of voice in their own destiny. This idea is one whose time has come and requires the development of management approaches that build employee involvement and shared objectives.

As can be seen from this, the thrust of current productivity improvements center around more effective planning and the increasing involvement by both management and workers to jointly address productivity issues. This also reflects the changing social norms and make-up in the working place. There is an ever decreasing gap between the educational and intelligence level of the work force and management. Similarly, as the cost of technology spirals upward and the price of new capital investments becomes ever more prohibitive, organizations begin to realize that worker productivity will have even more of an impact on revenues and, thus, profits. The old concern as to how a production effort will effect profits is being replaced with growing concern about its affects upon the work force. As Haggett so rightfully noted:

Perhaps this change in attitude from the 1960's and 1970's to where management is now saying, "We will work together to achieve program goals and objectives," is the most significant reformation that has taken place in our industry -- for without this attitudinal change, other reforms could not hope to produce desired improvements.

Unfortunately, the United States is late at realizing this. Japan's climb to the top of the industrial world has been greatly enhanced by its quality goals, achieved through such techniques as Quality Circles and management concern for employee welfare. And, this growth is aided by management realizing that the best point of attack for improving productivity is a

<sup>3</sup> Hinrichs, p. xii.

<sup>4</sup> Haggett, p. 4.

knowledgeable, dedicated, and technically competent first level supervisor. Likewise, while other Western countries were showing declines in productivity and growing labor unrest, Germany was improving its productivity annually. This fact was aided by such innovative measures as goal setting at the shop level and participative decision making by both union and management.

Applications of these concepts need not be left to just elements within an industry but could and should be applied to all areas where team work and joint concern for a project's welfare are common. This definitely includes the government/DoD contracting arena, especially in those areas such as shipbuilding, where joint efforts in R&D, design, and weapon systems integration require the utmost in cooperation. In the Navy shipbuilding process there are three major areas where productivity issues are most frequently encountered. These areas involve (1) the organization that plans and designs the project, (2) management of the ship production process, and (3) the management of the program itself, especially as it applies between shipbuilder and Navy Project management.

#### Organizational Development

Jay Galbraith, in his definitive study of complex organization designs, put forth the theory that "observed variations in organizational forms are actually variations in the strategies of organizations to (1) increase their ability to preplan, (2) increase their flexibility to adapt to their inability to preplan, or (3) decrease the level of performance required for continued viability." He goes on to stress that the driving force to such organizational designs is the necessity to process information which will facilitate task accomplishment. "As the volume of information becomes substantial, the organization either finds ways to process the information or discovers ways to avoid having to do so." Thus, in a decentralized and loosely organized organization, key informational elements and data may be overlooked, or, the necessary information may not be processed to the right managers for action and inclusion in its goals or objectives.

This problem definitely can occur during the design phase of a new shipbuilding project as the degree of informational uncertainty increases. Galbraith defines uncertainty as it relates to organizational design as "the relative amount of information that must be acquired during task performance. It is relative to the amount of information required and the amount already possessed by the organization." Consequently, if the expertise pertaining to the producibility of the ship is not apparent or

<sup>5</sup> Jay Galbraith, Designing Complex Organizations. (Reading, MA: Addison-Wesley Publishing Co., 1973), p. 4.

<sup>6</sup> Galbraith, p. 6.

<sup>7</sup> Galbraith, p. 5.

savaiable during the design phase, then productivity will not be adequately considered at that time. This would be a result of this issue being "O.B.E." due to the gaps in technical information and compressed design schedule. Consequently, poor design phase organizational development adversely affects the downstream production process.

### Management of the Production Process

The best control and development of productivity lies in the ability of the water-front supervisors. This is in keeping with Galbraith's four alternatives to reduce the degree of uncertainty (as shown by the information that has to be processed). This process is based upon improved lateral relations where lower level managers solve the problem at their own level by contacting and cooperating with their peers instead of referring it upward in the managerial heirarchy. However, in order for this to happen at the lower supervisory level, the organization must ensure that as much knowledge and understanding of the goals and objectives of the production process is made available to their waterfront supervisors. The success of Japan's Quality Circle program is a derivative of this concept. The production process must be adequately engineered and planned before the lateral relations concept can be successfully applied. Likewise, the first line supervisor must be thoroughly trained and possess the required managerial skills to resolve problems, motivate the workers, and coordinate with his peers. The result of this would be the placing of responsibility for productivity improvements at the level where productivity occurs. The end result would be a decrease in informational processing and corrective actions by upper level managers, thereby freeing more of their valuable time to developing better engineering plans and ensuring that the waterfront supervisors have the best design packages to work with. Similarly, these upper level managers will be better able to address major issues whose resolution involve more intricate and complex coordinating among the work force.

### Management of the Project

One of the major problems affecting both cost and schedule of modern weapon systems acquisition is the concurrency of development and production required to meet both time and fiscal constraints. The successful resolution of this demands more customer (in this case, the government and contractor) cooperation, understanding and involvement. In its attempts to meet the strategic and tactical specifications for its weapon system, military agencies are constantly evaluating the technology and designs for its equipment. Unless there is cooperation between the manufacturer and the government sponsor, this constant change process will have adverse impacts on both planning and productivity, not to mention cost. Just as it is important to have the most competent and knowledgeable team developing the ship design, it is just as crucial to have the proper technical expertise in the Navy project organization to ensure that budget and engineering change proposals will not impact the productivity improvements gained from the prior design planning phase and from the placing of top notch supervisors at the waterfront. Experience has shown that even when design engineering gets an acceptable package down to the waterfront,

a high percentage of Navy required rework due to ECPs results in both lost time and man-hours. This culminates in frustration for the work teams who receive no credit toward construction progress or goals as a result. Qualified ship production engineers must be an integral part of the Navy's management process in order for the Navy to actively contribute to productivity instead of becoming a hinderance.

## II PRODUCTIVITY ISSUES

As has been previously discussed, productivity improvements must be initiated at the management level. Part of the problem in improving productivity lies in creating an awareness of the areas where productivity is being impacted, whether through organizational design, informational overload, lack of properly trained managers at the waterfront level, or inexperienced technical insight as to impacts caused by program decisions. Three areas where productivity issues are apparent are the (1) early design phases, (2) Navy project management, and (3) waterfront management relationships with the shipbuilder.

### Design Development Issues

As Hinrichs pointed out, effective job design encompasses putting the proper skill mix together so that there is a balanced use of an organization's human resources. Galbraith stressed the importance of effective organizational development such that resolution of uncertainty is achieved at the lowest levels, thereby freeing an organization's upper levels to address more global issues. These components of productivity have direct application in the Navy's ship design community where frequently concern for producibility in design is often overtaken by more pressing demands of schedule and systems integration goals. William Haggett, president of Bath Iron Works, feels strongly that by placing emphasis on developing productivity enhanced designs, it will contribute greatly to the overall performance in ship construction: "We are convinced that more producibility emphasis in the Navy's early design process is not only desirable but feasible given present technology." He goes further to state that such efforts will result in more cost effective ships which will be built in less time and requiring less from the more skilled construction workers. And, since most of a work force's skilled craftsmen are frequently in a supervisory role, this will also allow them to spend more time on productivity improvements at their level.

In addition to Galbraith's studies on organizational development and its impact on informational processing, other studies have also highlighted the fact that an organization's hierarchical structure acts as a hinderance or aid to resolving problems and addressing major issues. In a decentralized organization, as exists where various projects are ongoing simultaneously, an informational processing gap exists between the upper

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<sup>8</sup> Hinrichs, p. xi.

<sup>9</sup> Haggett, p. 7.

and lower levels of management. The ability and resourcefulness of the teams working on the individual projects are not benefitted by a definite and concise set of objectives and priorities. Likewise, the approach to each team's task is ultimately flavored by the individual technical talent within each group. Unless upper level management takes the initiative to establish the overall goals and objectives for the organization, especially as they pertain to productivity, then there will be little or no lateral contact on this, as well as possible informational overload in the upper levels resulting from the vertical passing of problems upward for resolution. The Navy design community can ill afford to overlook such critical issues as productivity impacts of designs simply because it does not have the proper technical team mix or an inadequate structure to address the major production planning issues and objectives. Failure to involve knowledgeable and technically experienced production engineers in the design phase has resulted in short-sighted designs, whose schedule has been met, but has caused delays, rework, and frustration in the shipyard. This aspect of the design phase failure to evaluate productivity impacts will have a ripple effect throughout the production process. The engineering department, if it is properly considering producibility, will have to review and identify those areas requiring redesign. This in turn will impact the timely submission of producible plans to the waterfront. Those areas not properly identified and corrected will result in unnecessary rework and delays by the craftsmen. This in turn will cause the ship's work force to waste valuable time and energy that results in lost opportunity for them to gain on their own productivity goals. And, since rework results in 0% contribution to physical progress, the overall schedule progress of the vessel under construction will suffer. Finally, the Navy winds up paying for labor to correct design deficiencies that may have been contributed by its own design community. But, more importantly, the morale and efficiency of the work force will suffer. This loss in motivation could conceivably carry over into other aspects of the construction process and further erode productivity goals. As Mr. Haggett so aptly states, "With quality work performed on the front-end, even average mechanics can succeed, but if front-end work is mediocre, the best mechanics in the world cannot produce a high quality ship at low cost and on schedule. Truly, front end performance has a huge impact on final results."

### Shipyard Management Issues

When human resource management began to gain attention as a more likely approach to motivate employees, and thus improve productivity, several theories evolved that point out the basic requirements to this technique. McGregor's Theory Y (1957) maintained that the lack of employee motivation can not be cured purely through the outdated management control of reward (e.g. money) and punishment, but by management's attempts to provide a more participative and humane environment. Maslow's (1954) earlier work on need hierarchy supported the development of Theory Y by asserting that a man is motivated by basic needs which exist and can be

<sup>10</sup> Haggett, p. 6.

fulfilled through work. This important concept implies that work is a critical means by which a person's life goals can be realized. Consequently, if management establishes working conditions and environments to meet these physiological and psychological needs, workers will be more motivated and dedicated to realizing the organization's goals, such as improving productivity. These major post-war changes have had significant impact upon how an organization performs, and reflects the increasing mental and technical capabilities of the modern work force. Today's work force not only wants to feel an integral part of the overall project, but, has the ability to see where management is not doing its share as far as planning and supervising the efforts to reach goals and objectives. More recently, Dr. Edwin Locke at the Science of Productivity Conference in 1981 put forth a more up to date view in what he terms as Theory V, reflecting the more recent developments in work motivation. Theory V addresses the role of needs and values in guiding action; the role of value attainment in job satisfaction and productivity; the role of money and goal setting as motivation of job performance; techniques for motivating the utilization of knowledge in implementing goals; and the role of social factors as motivators and demotivators of job performance. All this attention and academic research point up to an organization recognizing that the leadership and motivation of its work force represents its best resource for producing at more productive levels and cost effective manners. The most visible example of this is again the practice shown by Japan. Here, the crux of all management initiatives and plans are based upon the team leaders on the plant floor. These team leaders organize and supervise their fellow employees to accomplish goals and objectives which they have established to accomplish the company's plan. There is considerable formal interaction between management and the work force through these supervisors and their Quality Circles (QC) groups. This approach has definitely benefitted Japan with products of the highest calibre and cost effective production.

With these new ideas in mind, the shipyard management will come to see that the most critical element in productivity improvements is the waterfront first line supervisor. This person represents the shipbuilder's most important investment in meeting schedules, resolving issues, and motivating the workforce. The mechanic on the waterfront has had, out of necessity, to become more technically capable to accomplish the highly complex tasks required of the Navy man-of-war. This new breed of shipyard worker is no longer just satisfied to make ends meet; he or she is looking for benefits, better working conditions and a leadership to which they can relate. Based upon his or her technical expertise, the first line supervisor is responsible for translating plans into sub-systems which eventually provide a very complex man-of-war. The first indication of problems in the designs of work packages will be most likely identified by this person. Because the supervisor works directly with the work force, he is the most capable of understanding their problems and difficulties, and resolving these roadblocks to productivity. The lowest level manager working with the work force represents the image and understanding that ship's labor have of shipyard management and its ability to plan effectively.

<sup>11</sup> Dr. Edwin A. Locke, "A New Look at Work Motivation: Theory V." Presentation at the Science of Productivity Conference, Washington, D.C. November 1981.

The changing nature of the modern work force requires that managers be more attuned to the human side of labor and be more sensitive to their needs and work requirements. The current work force is more intelligent and perceptive to poor management as displayed through their planning and control capabilities. Today's work force is more motivated by participative management than the traditional authoritarian approach. The best technician or skilled craftsman may not always represent the best supervisor. In addition to losing a productive worker by promoting to management positions, productivity may be further impacted by the lack of management skills he or she possess. Shipyard managers must evaluate their potential supervisors as to their ability to apply two dimensional thinking; to plan and resolve problems, and, more importantly, their capacity to be decisive and innovative toward productivity goals.

Inefficient or poor first level management creates more problems for the subsequent levels of shipyard management. The first level manager must be capable of understanding and carrying out the goals and objectives of the ship construction process. Concentrating only on the immediate work is one dimensional and prohibits long term productivity gains. If upper level management fails to involve the waterfront supervisors in the company's goals and objectives, these people will not be able to translate such objectives to the work force which ultimately is responsible for the achievement of those goals. Upper level management which fails to appreciate the impact that waterfront supervision has upon productivity will invariably be contributing to the failure to achieve their own objectives. Upper level managers are charged with providing both structure and information to the lower level management team. Failure to rely upon the more skilled waterfront supervisor to solve technical problems will cause non-productive solutions and possible decreases in motivation and morale. Failure to involve waterfront supervisors in the planning process also lends itself to inefficiency and non-productive goals as well as setting the stage for further construction problems. Galbraith highlighted this fact in his analysis on making lateral processes effective and improving project organizations:

At least a substantial minority of the work force must consist of managers who will subsequently be held responsible for the implementation of the project plans and goals ... the participation of line managers is essential if task forces or teams are to reduce information overloads. This means the group must arrive at an action decision. Therefore, the manager who is responsible for implementing the action, must participate... If an action decision is to be reached, the participants must have the information relevant to the decisions with which the group is charged. The appropriate solution is to have lower-level personnel represent the department. These people are usually first - and second-level technical people. They are the ones in day-to-day contact with the technology and techniques .

<sup>12</sup> Galbraith, p. 55-57.

## Navy Management Issues

The structure and organizational design of a Navy Project Office lends itself to the development of good technical and participative management approaches. A Navy Project Office compares favorably to the three basic design strategies Galbraith maintains will provide sufficient impetus to successful task completions. Thus, a typical shipbuilding project office is based upon:

- 0 the creation of self contained tasks (such as the ILS or Production Management sections) which concentrate their efforts on specific technical issues,
- 0 investments in various vertical information systems (such as a production information management system or project risk systems),
- 0 and, the encouraging of lateral relationships, (as shown by the interactions between sections as well as between project managers and their peers at both the shipyard and SUPSHIP).

However, whenever understaffing or poor planning weakens one of these elements, as happens when technically less qualified managers fill the production management position, then even the best intentions can result in complications with productivity plans. Navy managers who try to forcibly "direct" their areas of the project without fully understanding the nature and problems of shipbuilding processes often complicate the attempts to improve productivity. Quick fixes and decisions on potential problems without more comprehensive analyses that are forced on the shipbuilder will invariably defeat any long term gains. Navy project managers must establish solid team relationships with their shipyard counterparts and work together to resolve issues leading to successful productivity. Adversarial roles only break down communication and lower morale.

Navy management, through neglect of proper production planning, finds themselves spending more of their time trying to explain schedule slippages and cost overruns than concentrating on how the Navy and the shipbuilder, together, can stick to and achieve their schedule and budget goals. Failure to adequately understand shipbuilding production processes will lay the foundation for making counter productive judgements concerning design and construction options.

In addition to possessing sufficient technical knowledge, Navy managers who do not have a systematic and thorough data analysis and problem identification process will not be able to fully capitalize on the abundant data and information they receive. This in turn will prohibit their understanding of the production process. Also, unless Navy managers establish a good and solid working relationship with the shipbuilder's

<sup>13</sup> Galbraith, p. 19.

<sup>14</sup> Ibid., p. 15.



managers, the quality and quantity of their information is subject to decline as a result of a lack of understanding of the Navy manager's needs and of poor communication. Navy managers must possess a comparable level of expertise with their shipbuilder counterparts or the communication process so vital to good team work will never materialize. This aspect cuts across the entire spectrum of knowledgeable exchange and joint resolution of problems affecting productivity.

### III SUMMARY

Increasingly greater emphasis is being placed upon improving productivity through innovative management techniques. To be able to achieve these improvements, management must adopt a more humanistic approach with their work force, develop participative environments, and further develop their technical expertise in order to facilitate the overall communication process.

We have not sufficiently recognized the direct relationship of human factors engineering and motivation on productivity. "The results of these conditions in the labor market of Japan are that shipyard workers are company-oriented, committed to long term employment, and highly regarded by their peers. High worker productivity can therefore be understood... Without consideration of these vital elements, centered around humane use of human beings, any assessment of shipbuilding technology, functional management, and production processes, will find only partial definition the system under review with incomplete findings and conclusions.\*\* three critical areas where these factors can be addressed are in the engineering design, production and Navy management phases. The issues identified in this paper can all be related to impacting productivity and are subject to change for the better if productivity and sound management can be embraced as a single entity.

<sup>15</sup> Raymond Ramsay, "A Time for Shipbuilding Renaissance," Paper for The North East Coast Institution of Engineers & Shipbuilders, England, 1982. p. 37.

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